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(54) **Enzymes in combination with polyelectrolytes for enhancing the freeness of clarified sludge or recycle old newsprint in papermaking**

Enzyme zusammen mit Polyelektrolyten zur Erhöhung der Entwässerung von Schlamm oder Kreislaufzeitungsdruckpapier bei der Papierherstellung

Combinaison d'enzymes de polyélectrolytes pour améliorer l'égouttabilité de boue clarifiée ou de vieux papier journal recyclé lors de la fabrication de papier

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(56) References cited:
EP-A- 0 262 040 **EP-A- 0 291 665**
EP-A- 0 671 507 **US-A- 5 169 497**
US-A- 5 266 164 **US-A- 5 423 946**

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The file contains technical information submitted after the application was filed and not included in this specification

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Description

Background of the Invention

Field of the Invention

[0001] The invention relates to the use of a combination of cellulolytic enzymes with cationic and anionic polymers in specific amounts for enhancing the freeness of clarified sludge or old newsprint pulp (ONP) as recycle furnish in paper making. In particular, the invention relates to a process for enhancing the freeness of clarified sludge or old newsprint pulp as recycle furnish in paper making.

Description of the prior art

[0002] More and more the papermaking industry uses recycled papers. For example, for the manufacture of corrugated cardboard, raw materials which are based on recycled fibers are being used more frequently and, at the same time, the number of recyclings is increased. With each recycling, the quality of the raw materials is lessened so that fiber strength is reduced, and more fines are generated. Further, more contaminants are accumulated. All of these problems result in decreasing freeness of pulp.

[0003] On type of recycle furnish (an aqueous suspension that has gone through the papermaking process 1 to 2 times) used in papermaking is so-called clarified sludge. Clarified sludge is a concentrate of pulp and paper mill effluent which contains solids primarily in the form of fiber fines. The fiber fines found in clarified sludge usually are smaller than 10 μm . Also contained within clarified sludge are hemicellulose and chemical substances such starch, rosin, alum hat melts (commonly referred to as stickies and tackies) and organic matter. The clarified sludge contains abundant viscous microbial polysaccharides. These biopolymers hold copious amounts of water and are difficult to treat with conventional methods. Enzymes can break down the polysaccharide structure which may enhance the drainage of the sludge.

[0004] Clarified sludge is typically land filled at a tremendous cost to the paper makers and the environment. The amount and types of fines (commonly referred to as "anionic trash") are too difficult and uneconomical to treat by conventional mechanical/chemical methods. These methods include refining, screening and treatment with retention and drainage aids. By improving the freeness of sludges it is possible to blend them into papermaking pulp furnishes. Due to this practice the overall cost of the pulp furnish can be substantially reduced and also the load of landfilling can be reduced.

[0005] Another type of recycle furnish is old newsprint pulp (ONP) which should also be distinguished from other recycle pulps including old corrugated containers

(OCC) which are treated in a pulper with hot water under a continuous agitation until a pulp is produced. Typically, OCC fibers have a greater length than clarified sludge, since they are a mixture of chemical mechanical pulp (CMP) and chemical thermal mechanical pulp (CTMP) which are derived from hardwoods and kraft cuttings. Further, OCC differs from clarified sludge in many physical characteristics, including consistency, bulk viscosity, pH, charge, fiber strength and the composition of solid contents.

[0006] The pulps in aqueous suspension which are ready to be used on a paper machine can be characterized by various parameters, one of which is particularly significant for predicting the draining capability of the pulp. A measure of the drainability of the pulp is frequently expressed in the term "freeness". Specifically, freeness is measured according to Canadian Standard Freeness, or CSF measurement. CSF measures the drainage of 3 grams (oven dried weight) of pulp suspended in one liter of water.

[0007] The use of cellulolytic enzymes, e.g. the cellulases and/or the hemicellulases for treating recycled paper pulps to improve freeness is disclosed in US-A-4 923 565. The cellulase enzyme described therein may be used in the practice of the present invention.

[0008] EP-A-0 671 507 (corresponding to US-A-5 423 946) which belong to the prior art according to Article 54 (3) EPC describe processes for improving the freeness of paper pulp the main starting product for papermaking and as such being different from papermill sludges and recycled old newsprint pulp which are treated according to the present invention.

[0009] Sludges are formed due to microbial degradation of various organics present in papermill effluent treatment systems and all paper pulp furnishes used in the manufacture of paper are drastically different from such sludges. Sludges are a consortium of microbial biomass, high in ash content (about 80 %), in organic/organic fines, smaller than 10 μm and contain polysaccharides and protein. According to Nilson (H. Ryssov-Nielsen: "Vatten" 1975, vol. 31, pages 33-39) water is bound to the sludges by extracellular polymeric compounds produced by the microorganisms which create problems in dewatering. In contrary, paper pulp furnishes are plant biomass (fibers) and their compositions are different from sludges.

[0010] US-A-5 266 164 refers to a method for improving the retention of mineral fillers and cellulose fibers on a cellulosic fiber sheet by using both a cationic copolymer flocculant and an anionic flocculant. Both additives are added to a usual papermaking pulp and not to a clarified sludge or a recycle old newsprint pulp as treated according to the present invention. Furthermore, the use of an enzyme is not even mentioned in this document.

[0011] EP-A-0 291 665 refers to a process for improving the dewatering of biological sludge by using cellulase and a cationic polyelectrolyte as a flocculant. This process is fundamentally different from the process of

the present invention.

[0012] US-A-5 169 497 refers to a process for improving freeness of paper pulp which process is quite similar to the processes described in EP-A-0 671 507 and US-A-5 423 946. Furthermore, the process disclosed in US-A-5 169 497 does not comprise step (d) of the process of the present invention. This document which represents the closest prior art discusses the effects of cellulases in combination with cationic flocculants of varying composition on the freeness of old corrugated containers (OCC) pulp. The above patent covers the use of a combination of enzyme and cationic polymers for enhancing the freeness of recycled fiber. In practice, dual polymer treatment programs are also used for retention.

[0013] The pulp is first treated with a cellulolytic enzyme followed by cationic and anionic polymers. In a dual polymer retention system, two synthetic polymers are mixed with the pulp sequentially to achieve better results than obtained with either polymer by itself. Usually, a low molecular weight, highly charged cationic polymer is added to the papermaking furnish first, and then at a later stage, a high molecular weight, anionic polymer is added. Dual polymers have found a place in paper and board manufacturing. Good retention has numerous economic benefits. As the use of recycled fiber increases in container board, fine paper, and newsprint grades, the opportunity to provide benefits through retention aids has also increased. If fines are not retained by a good retention aid or hydrolyzed by an enzyme, they will impede drainage, fill felts, and cause deposition problems. The key benefit of retention aids with enzyme is to prevent drainage reduction and subsequent loss of machine speed. Drainage can be maintained by preventing the build-up of fines in the white water loop.

[0014] US-A-5 308 449 discusses the use of enzymes as a method of treating recycled paper for use as a papermaking pulp. However, this document does not address the problem of clarified sludge in the recovery of pulp from within that sludge for later use in papermaking. Further, there is no discussion therein of the use of treatment agents for enhancing the freeness and drainability of pulp once the recycled paper has been introduced back into the papermaking process.

[0015] Ideally, a method would exist which would allow for the recovery of paper pulp from clarified sludge and ONP while at the same time increasing the freeness and drainability of any resulting paper pulp once it is processed through the papermaking machinery.

[0016] The object of the present invention is to disclose a method of treating previously unused clarified sludge and recycle old newsprint pulp (ONP) for re-use in the papermaking system. By re-using clarified sludge and ONP, substantial economic benefits may be derived in terms of decreased waste removal cost as well as increased efficiency in the use of materials by the papermaking industry. Since old newsprint pulp is significantly less costly than OCC pulp, papermaking mills will recognize significant economic benefits.

Summary of the Invention

[0017] The above object of the invention is achieved by a process for enhancing the freeness of clarified sludge and/or ONP, which comprises the steps of adding to the pulp at least 0.05 %, based on the dry weight of the pulp, of a cellulolytic enzyme, allowing the pulp to contact the cellulolytic enzyme for from about 40 minutes to about 60 minutes at a temperature of at least 40°C, adding at least 0.01 %, based on the dry weight of the pulp, of a water soluble cationic polymer, and adding at least 0.007 %, based on the dry weight of the pulp, of a specific water soluble anionic polymer.

[0018] Subject-matter of the present invention according to a first aspect is a process for enhancing the freeness of clarified sludge which comprises the sequential steps of:

- a) adding to the sludge at least 0.05 %, based on the dry weight of the sludge, of a cellulolytic enzyme;
- b) allowing the sludge to contact the cellulolytic enzyme for from 30 to 60 minutes at a temperature of from 20 to 60°C;
- c) adding at least 0.01 %, based on the dry weight of the sludge, of a water-soluble cationic polymer; and
- d) adding at least 0.007 %, based on the dry weight of the sludge, of a water-soluble anionic polymer selected from the group consisting of polymers and copolymers of acrylamide and/or (meth)acrylic acid and mixtures thereof.

[0019] According to preferred embodiments of the present invention

in step (a) 0.05 to 0.4 %, based on the dry weight of the sludge, of the cellulolytic enzyme are added to the sludge;

in step (b) the sludge is allowed to contact the cellulolytic enzyme for about 40 minutes at a temperature of from 40 to 60°C, preferably of about 40°C ;

in step (c) from 0.01 to 0.08 %, preferably from 0.02 to 0.025 %, based on the dry weight of the sludge, of the water-soluble cationic polymer are added; and

in step (d) from 0.025 to 0.075 %, based on the dry weight of the sludge, of the water-soluble anionic polymer are added.

[0020] The preferred water-soluble cationic polymer used according to the present invention is a copolymer which contains from 20 to 80 % by weight of acrylamide.

[0021] A particularly preferred cationic acrylamide copolymer used according to the present invention is an

acrylamide-diallyldimethyl ammonium chloride copolymer.

[0022] A preferred anionic polymer used according to the present invention is an acrylamide polymer comprising from 20 to 95 % of acrylamide and from 80 to 5 % of an anionic monomer, each based on the weight of the polymer, wherein the anionic monomer preferably is selected from the group consisting of acrylic acid and methacrylic acid.

[0023] Subject-matter of the present invention according to a further aspect is a process for enhancing the freeness of recycle old newsprint pulp which comprises the sequential steps of:

- a) adding to the pulp at least 0.05 %, based on the dry weight of the pulp, of a cellulolytic enzyme;
- b) allowing the pulp to contact the cellulolytic enzyme for from 30 to 60 minutes at a temperature of at least 40°C ;
- c) adding at least 0.01 %, based on the dry weight of the pulp, of a water-soluble cationic polymer; and
- d) adding at least 0.007 %, based on the dry weight of the pulp, of a water-soluble anionic polymer selected from the group consisting of polymers and copolymers of acrylamide and/or (meth)acrylic acid and mixtures thereof.

[0024] A preferred water-soluble cationic polymer used according to the present invention is a copolymer which contains from 20 to 80 % by weight of acrylamide. A particularly preferred cationic acrylamide copolymer is an acrylamide-diallyldimethyl ammonium chloride copolymer.

[0025] A preferred water-soluble anionic polymer used according to the present invention is an acrylamide copolymer comprising from 20 to 95 % of acrylamide and from 80 to 5 % of an anionic monomer each based on the weight of the copolymer, wherein the anionic monomer preferably is selected from the group consisting of acrylic acid and methacrylic acid.

Description of the Preferred Embodiments

[0026] A variety of water soluble cationic coagulants may be used in the practice of the invention. Both condensation and vinyl addition polymers may be employed. For a list of water soluble cationic polymers, reference may be had to CA-A-731 212.

[0027] A preferred group of cationic polymers are the cationic polymers of acrylamide which in a more preferred embodiment of the invention, contain from 40 to 89 % by weight of acrylamide. Larger or smaller amounts of acrylamide in the polymers may be used, e. g., between 30-80%. Typical of the cationic monomers, polymerized with acrylamide are the monomers diallyldimethyl ammonium chloride, (DADMAC), dimethylaminoethyl/acrylate methyl chloride quaternary ammonium salt, (DMAEA.MCQ), epichlorohydrin dimethylamine

condensate polymer (epi-DMA) and ethylene dichloride (EDC-NH₃). When these cationic acrylamide polymers are used they should have a RSV (reduced specific viscosity) of at least 3 and preferably the RSV should be within the range of 5-20 or more. RSV was determined using a one molar sodium nitrate solution at 30°C. The concentration of the acrylamide polymer in this solution is 0.045 %.

[0028] A preferred group of anionic polymers are copolymers of acrylamide containing 20 - 95% acrylamide and 80 to 5% anionic monomer by weight of the copolymer such as acrylic acid or methacrylic acid.

[0029] The invention has utility in improving the drainage or the freeness of a wide variety of sludges, paper pulps, including Kraft and other types of pulp. The invention is particularly useful in treating pulps that contain recycled fibers. The effectiveness of the invention in improving drainage is most notable when the pulps contain at least 10 percent by weight of recycled fiber, with great improvements being evidenced when the recycled fiber content or the pulp being treated is at least 50% or more.

[0030] As indicated, the invention requires that the sludge or pulp first be treated with an enzyme, then with a cationic polymer and, finally, with an anionic polymer. It is also important to the successful practice of the invention, that the conditions under which the treatment with the enzyme occurs is such to provide optimum reaction time of the enzyme of the pulp or sludge.

[0031] The treatment of the sludge or pulp with the enzyme is conducted for a period of time not greater than 60 minutes. The minimum treating time is about 30 minutes. A preferred treating time would be about 40 minutes. The pH of the pulp to achieve optimum results should be between the ranges of 5 to 7.5. The temperature of the treatment should not be below 20°C, and usually should not exceed 60°C. A preferred average reaction temperature is 40°C.

[0032] A preferred dosage of the cationic polymer, as actives, is from 0.01% to 0.08% by weight of the polymer, based on the dry weight of the sludge or pulp. The most preferred dosage which may be used to treat the pulp with the cationic polymer is from 0.025% to 0.02% polymer based on the dry weight of the pulp or sludge.

[0033] The preferred dosage of anionic polymer, as actives, is from 0.025% to 0.075% polymer based on the dry weight of the pulp or sludge.

[0034] The enzyme dosage based on the dry weight of the pulp or sludge in a preferred embodiment ranges from about 0.05 to about 0.4 percent by weight. The most preferred treatment range of the enzyme that may be used is from 0.1 to 0.2 percent by weight.

[0035] In order for the enzyme to have sufficient reaction time and mixing described above, it is necessary that they be added to the pulp or sludge at the point in the paper making system to allow sufficient time for the above conditions to occur. Thus, a typical addition point in paper making system would be the machine chest.

Other places where suitable contact time would occur may also be used as additional points.

Claims

1. A process for enhancing the freeness of clarified sludge in papermaking which comprises the sequential steps of:
 - a) adding to the sludge at least 0.05 %, based on the dry weight of the sludge, of a cellulolytic enzyme;
 - b) allowing the sludge to contact the cellulolytic enzyme for from 30 to 60 minutes at a temperature of from 20 to 60°C;
 - c) adding at least 0.01 %, based on the dry weight of the sludge, of a water-soluble cationic polymer; and
 - d) adding at least 0.007 %, based on the dry weight of the sludge, of a water-soluble anionic polymer selected from the group consisting of polymers and copolymers of acrylamide and/or (meth)acrylic acid and mixtures thereof.
2. The process according to claim 1, wherein in step (a) 0.05 to 0.4 %, based on the dry weight of the sludge, of the cellulolytic enzyme are added to the sludge.
3. The process according to any of claims 1 and 2, wherein in step (b) the sludge is allowed to contact the cellulolytic enzyme for about 40 minutes at a temperature of from 40 to 60°C, preferably of about 40°C.
4. The process according to any of claims 1 to 3, wherein in step (c) from 0.01 to 0.08 %, preferably from 0.02 to 0.025 %, based on the dry weight of the sludge, of the water-soluble cationic polymer are added.
5. The process according to any of claims 1 to 4, wherein in step (d) from 0.025 to 0.075 %, based on the dry weight of the sludge, of the water-soluble anionic polymer are added.
6. The process according to any of claims 1 to 5, wherein the water-soluble cationic polymer is a copolymer which contains from 20 to 80 % by weight of acrylamide.
7. The process according to claim 6, wherein the cationic acrylamide copolymer is an acrylamide-diallyldimethyl ammonium chloride copolymer.
8. The process according to any of claims 1 to 7, wherein the anionic polymer is an acrylamide poly-

mer comprising from 20 to 95 % of acrylamide and from 80 to 5 % of an anionic monomer, each based on the weight of the polymer.

9. The process according to claim 8, wherein the anionic monomer is selected from the group consisting of acrylic acid and methacrylic acid.
10. A process for enhancing the freeness of recycle old newsprint pulp in papermaking which comprises the sequential steps of:
 - a) adding to the pulp at least 0.05 %, based on the dry weight of the pulp, of a cellulolytic enzyme;
 - b) allowing the pulp to contact the cellulolytic enzyme for from 30 to 60 minutes at a temperature of at least 40°C;
 - c) adding at least 0.01 %, based on the dry weight of the pulp, of a water-soluble cationic polymer; and
 - d) adding at least 0.007 %, based on the dry weight of the pulp, of a water-soluble anionic polymer selected from the group consisting of polymers and copolymers of acrylamide and/or (meth)acrylic acid and mixtures thereof.
11. The process according to claim 10, wherein the water-soluble cationic polymer is a copolymer which contains from 20 to 80 % by weight of acrylamide.
12. The process of claim 11, wherein the cationic acrylamide copolymer is an acrylamide-diallyldimethyl ammonium chloride copolymer.
13. The process according to any of claim 10 to 12, wherein the anionic polymer is an acrylamide copolymer comprising from 20 to 95 % of acrylamide and from 80 to 5 % of an anionic monomer each based on the weight of the copolymer.
14. The process according to claim 13, wherein the anionic monomer is selected from the group consisting of acrylic acid and methacrylic acid.

Patentansprüche

1. Verfahren zu Verbesserung der Entwässerbarkeit von Klärschlamm bei der Papier-Herstellung, das die folgenden aufeinanderfolgenden Stufen umfaßt:
 - a) Zugabe von mindestens 0,05 %, bezogen auf das Trockengewicht des Schlammes, eines cellulolytischen Enzyms zu dem Schlamm;
 - b) Kontaktieren des Schlammes mit dem cellulolytischen Enzym für 30 bis 60 min bei einer

Temperatur von 20 bis 60°C;

c) Zugabe von mindestens 0,01 %, bezogen auf das Trockengewicht des Schlammes, eines wasserlöslichen kationischen Polymers; und

d) Zugabe von mindestens 0,007 %, bezogen auf das Trockengewicht des Schlammes, eines wasserlöslichen anionischen Polymers, ausgewählt aus der Gruppe, die besteht aus Polymeren und Copolymeren von Acrylamid und/oder (Meth)Acrylsäure und Mischungen davon.

2. Verfahren nach Anspruch 1, bei dem in der Stufe (a) 0,05 bis 0,4 %, bezogen auf das Trockengewicht des Schlammes, des cellulolytischen Enzyms zu dem Schlamm zugegeben werden.

3. Verfahren nach einem der Ansprüche 1 und 2, bei dem in der Stufe (b) der Schlamm etwa 40 min lang bei einer Temperatur von 40 bis 60°C, vorzugsweise von etwa 40°C, mit dem cellulolytischen Enzym kontaktiert wird.

4. Verfahren nach einem der Ansprüche 1 bis 3, bei dem in der Stufe (c) 0,01 bis 0,08 %, vorzugsweise 0,02 bis 0,025 %, bezogen auf das Trockengewicht des Schlammes, des wasserlöslichen kationischen Polymers zugegeben werden.

5. Verfahren nach einem der Ansprüche 1 bis 4, bei dem in der Stufe (d) 0,025 bis 0,075 %, bezogen auf das Trockengewicht des Schlammes, des wasserlöslichen anionischen Polymers zugegeben werden.

6. Verfahren nach einem der Ansprüche 1 bis 5, worin das wasserlösliche kationische Polymer ein Copolymer ist, das 20 bis 80 Gew.-% Acrylamid enthält.

7. Verfahren nach Anspruch 6, worin das kationische Acrylamid-Copolymer ein Acrylamid/Diallyldimethylammoniumchlorid-Copolymer ist.

8. Verfahren nach einem der Ansprüche 1 bis 7, worin das anionische Polymer ein Acrylamid-Polymer ist, das 20 bis 95 % Acrylamid und 80 bis 5 % eines anionischen Monomers, jeweils bezogen auf das Gewicht des Polymers, umfaßt.

9. Verfahren nach Anspruch 8, worin das anionische Monomer ausgewählt wird aus der Gruppe, die besteht aus Acrylsäure und Methacrylsäure.

10. Verfahren zur Verbesserung der Entwässerbarkeit von recycelter Zeitungsaltpapier-Pulpe bei der Papier-Herstellung, das die folgenden aufeinanderfolgenden Stufen umfaßt:

a) Zugabe von mindestens 0,05 %, bezogen

auf das Trockengewicht der Pulpe, eines cellulolytischen Enzyms zu der Pulpe;

b) Kontaktieren der Pulpe mit dem cellulolytischen Enzym für 30 bis 60 min bei einer Temperatur von mindestens 40°C ;

c) Zugabe von mindestens 0,01 %, bezogen auf das Trockengewicht der Pulpe, eines wasserlöslichen kationischen Polymers; und

d) Zugabe von mindestens 0,007 %, bezogen auf das Trockengewicht der Pulpe, eines wasserlöslichen anionischen Polymers, ausgewählt aus der Gruppe, die besteht aus Polymeren und Copolymeren von Acrylamid und/oder (Meth)Acrylsäure und Mischungen davon.

11. Verfahren nach Anspruch 10, worin das wasserlösliche kationische Polymer ein Copolymer ist, das 20 bis 80 Gew.-% Acrylamid enthält.

12. Verfahren nach Anspruch 11, worin das kationische Acrylamid-Copolymer ein Acrylamid/Diallyldimethylammoniumchlorid-Copolymer ist.

13. Verfahren nach einem der Ansprüche 10 bis 12, worin das anionische Polymer ein Acrylamid-Copolymer ist, das 20 bis 95 % Acrylamid und 80 bis 5 % eines anionischen Monomers, jeweils bezogen auf das Gewicht des Copolymers, umfaßt.

14. Verfahren nach Anspruch 13, worin das anionische Monomer ausgewählt wird aus der Gruppe, die besteht aus Acrylsäure und Methacrylsäure.

Revendications

1. Procédé pour améliorer la drainabilité de boue de curage lors de la fabrication de papier qui comprend les étapes successives suivantes:

a) addition d'au moins 0,05%, par rapport au poids sec de la boue, d'un enzyme cellulosique;

b) permettant à la boue de contacter l'enzyme cellulosique pendant 30 à 60 minutes à une température de 20 à 60°C;

c) addition d'au moins 0,01%, par rapport au poids sec de la boue, d'un polymère cationique soluble dans l'eau; et

d) addition d'au moins 0,007%, par rapport au poids sec de la boue, d'un polymère anionique soluble dans l'eau choisi du groupe constitué par des polymères et copolymères d'amide acrylique et/ou d'acide (méth)acrylique et leurs mélanges.

2. Procédé selon la revendication 1, dans lequel on ajoute dans l'étape (a) à la boue 0,05 à 0,4%, par rapport au poids sec de la boue, de l'enzyme cellu-

losique.

3. Procédé selon l'une quelconque des revendications 1 et 2, dans lequel, dans l'étape (b), on met la boue en contact avec l'enzyme cellulosique pendant environ 40 minutes à une température entre 40 et 60°C, de préférence environ 40°C.

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4. Procédé selon l'une quelconque des revendications 1 à 3, dans lequel, dans l'étape (c), on ajoute 0,01 à 0,08%, de préférence 0,02 à 0,025%, par rapport au poids sec de la boue, du polymère cationique soluble dans l'eau.

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5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel, dans l'étape (d), on ajoute 0,025 à 0,075%, par rapport au poids sec de la boue, du polymère anionique soluble dans l'eau.

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6. Procédé selon l'une quelconque des revendications 1 à 5, dans lequel le polymère cationique soluble dans l'eau est un copolymère qui contient 20 à 80% en poids d'amide acrylique.

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7. Procédé selon la revendication 6, dans lequel le copolymère cationique d'amide acrylique est un copolymère d'amide acrylique et de diallyldiméthyl chlorure d'ammonium.

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8. Procédé selon l'une quelconque des revendications 1 à 7, dans lequel le polymère anionique est un polymère d'amide acrylique qui contient 20 à 95% d'amide acrylique et 80 à 5% d'un monomère anionique, respectivement par rapport au poids du polymère.

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9. Procédé selon la revendication 8, dans lequel le monomère anionique est choisi du groupe constitué d'acide acrylique et d'acide méthacrylique.

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10. Procédé pour améliorer la drainabilité de pâte recyclée d'un vieux papier journal lors de la fabrication de papier qui comprend les étapes successives suivantes:

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a) addition à la pâte d'au moins 0,05%, par rapport au poids sec de la pâte, d'un enzyme cellulosique;

b) permettant à la pâte de contacter l'enzyme cellulosique pendant 30 à 60 minutes à une température d'au moins 40°C;

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c) addition d'au moins 0,01%, par rapport au poids sec de la pâte, d'un polymère cationique soluble dans l'eau ; et

d) addition d'au moins 0,007%, par rapport au poids sec de la pâte, d'un polymère anionique soluble dans l'eau choisi du groupe constitué par des polymères et des copolymères d'amide

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acrylique et/ou d'acide (méth)acrylique et leurs mélanges.

11. Procédé selon la revendication 10, dans lequel le polymère cationique soluble dans l'eau est un copolymère qui contient 20 à 80% en poids d'amide acrylique.

12. Procédé selon la revendication 11, dans lequel le copolymère cationique d'amide acrylique est un copolymère d'amide acrylique et de diallyldiméthyl chlorure d'ammonium.

13. Procédé selon l'une quelconque des revendications 10 à 12, dans lequel le polymère anionique est un copolymère d'amide acrylique qui contient 20 à 95% d'amide acrylique et 80 à 5% d'un monomère anionique respectivement par rapport au poids du copolymère.

14. Procédé selon la revendication 13, dans lequel le monomère anionique est choisi du groupe constitué par l'acide acrylique et l'acide méthacrylique.